Health Consultation

TETRACHLOROETHENE CONTAMINATION OF A PRIVATE WATER SUPPLY SYSTEM NEAR MASON COUNTY LANDFILL SHELTON, MASON COUNTY, WASHINGTON

August 16, 1999

Prepared by
The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Washington State Department of Health

FOREWORD

The Washington State Department of Health (DOH) has prepared this Health Consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This Health Consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this Health Consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. The Health Consultation allows DOH to respond quickly to a request from concerned residents for health information on hazardous substances. It provides advice on specific public health issues. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health.

For additional information or questions regarding DOH, ATSDR or the contents of this Health Consultation, please call the Health Advisor who prepared this document:

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BACKGROUND AND STATEMENT OF ISSUES

The Washington State Department of Health (WDOH) has prepared this health consultation at the request of the Mason County Department of Health Services to evaluate the potential health hazards associated with exposure to tetrachloroethene detected in a private water supply system near the Mason County Landfill. WDOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

The private water supply system consists of two wells that are located approximately 1,400 feet east of the Mason County Landfill, a closed landfill with a currently operating transfer station, and 1,100 feet southwest of an auto salvage yard near Shelton in Mason County, Washington (Figures 1 and 2). The older of the two wells within the system is located in a shallow, unconfined aquifer.[1] The newer well, which was drilled in June 1990, is located in a deeper, confined aquifer and was drilled because of rust problems associated with the older well.[1, 2] Based on post-closure groundwater monitoring at and downgradient of the landfill, groundwater in the shallow, unconfined aquifer appears to flow east to southeast toward the private water supply system.[3, 4] No information is available regarding the groundwater flow direction in the deeper, confined aquifer.[3, 4]

The private water supply system is sampled as part of the post-closure groundwater monitoring being conducted at the Mason County Landfill and was also sampled prior to the landfill closure in 1993. On four separate occasions, groundwater from the older well was analyzed for tetrachloroethene and other volatile organic compounds, semi-volatile organic compounds, metals, and conventional landfill parameters from November 1989 to November 1990. Subsequent sampling at the water supply system was conducted in the newer well on an approximately quarterly basis from February 1991 to the present.[2, 5] Groundwater from the new well was also sampled for organic compounds, metals, and conventional landfill parameters.

The November 1989 to February1999 tetrachloroethene results were evaluated by WDOH in preparing this health consultation. The use of this data, however, is not meant to imply that the landfill is the source of the tetrachloroethene contamination detected in the private water supply system. Sources of tetrachloroethene, other than the landfill, may exist.[6]

WDOH assumes that adequate quality assurance and quality control measures were followed with regard to sampling procedures, chain-of-custody, laboratory procedures, and data reporting. The validity of the analyses and the conclusions drawn for this health consultation are determined by the availability and reliability of the referenced information.

The maximum detected concentrations of tetrachloroethene, the contaminant of concern in the private water supply system, is provided in Table 1 along with the ATSDR drinking water screening values for carcinogens and non-carcinogens.

DISCUSSION

Groundwater samples collected from the private water supply system historically contained elevated concentrations of tetrachloroethene. Tetrachloroethene was first detected at the older water supply well in November 1989. The estimated concentrations detected in the older well ranged from 0.6 to <1.0 micrograms per liter (ug/l) during the four sampling rounds conducted through November 1990.[1] Samples collected at the newer well, beginning in February 1991, contained no detectable levels of tetrachloroethene through March 1995. However, the tetrachloroethene detection limit during that period was higher than levels previously detected. In September 1995, the tetrachloroethene detection limit was lowered to 0.2 ug/l. Since September 1995, tetrachloroethene has been detected in the water supply system ranging from 0.2 to 0.4 ug/l.[1, 3, 4] Tetrachloroethene was detected at 0.3 ug/l during the February 1999 sampling round, the last sampling round results available for the private water supply system.[7]

Tetrachloroethene is a synthetic chemical that is widely used for dry cleaning of fabrics and metal degreasing. It is a contaminant that has been detected at many hazardous waste sites throughout the county and has been detected in monitoring wells installed in the shallow, unconfined aquifer at the Mason County Landfill.[8] The most important routes of exposure to tetrachloroethene is through inhalation of the contaminant in ambient air and ingestion of contaminated drinking water.[8] Available data indicate that dermal exposure is generally not an important route of exposure for most people.[8]

Residents who historically used the water supply well system have been exposed to tetrachloroethene through ingestion, inhalation, and dermal contact with the water. To conduct the health consultation, the maximum tetrachloroethene concentration detected during the private water supply system monitoring from November 1989 to November 1998 (0.8J ug/l) was used to estimate past exposures. Tetrachloroethene data are not available for the water supply system prior to 1989. It is assumed that tetrachloroethene concentrations, if they existed, would have been similar or only slightly higher than the maximum concentration because there does not appear to be a major source of tetrachloroethene near the water supply system. Using the maximum concentration, however, results in a very conservative estimate since tetrachloroethene was only detected once at the maximum concentration over the nine year period. To evaluate current exposure, the tetrachloroethene concentration detected at the private water supply system in February 1999 (0.3 ug/l), the last sampling results available for the system, was used. Future exposures were estimated based on tetrachloroethene concentration trends observed in the water supply system.

Initially, the current and past maximum tetrachloroethene concentrations (0.3 and 0.8J ug/l, respectively) were compared to conservative ATSDR drinking water screening values for a preliminary evaluation of the potential health effects associated with the contaminants in the water supply system. ATSDR screening values are media-specific health comparison values used to determine whether carcinogenic and non-carcinogenic health effects would occur as a result of exposure to chemicals. The past maximum tetrachloroethene concentration detected in the water supply system did not exceed the non-carcinogenic screening level for tetrachloroethene and only slightly exceeded the carcinogenic screening value (Table 1). Neither the carcinogenic nor the non-

carcinogenic screening values were exceeded by the current tetrachloroethene concentration (Table 1).

A more detailed evaluation was conducted to determine potential non-carcinogenic health effects and the carcinogenic cancer risk posed by the tetrachloroethene concentrations detected in the wells. A child exposure scenario (0 to 5 years) was used to evaluate non-cancer health effects; a 30 year, child through adult exposure scenario was used to evaluate cancer health effects. Appendix A summarizes the exposure assumptions used to calculate an exposure dose. Appendix B summarizes how the exposure doses were used to evaluate potential non-carcinogenic health effects and the carcinogenic cancer risk.

The results of the detailed evaluation indicate that neither non-cancer health effects nor a significant cancer risk is anticipated to occur through exposure to the current concentration of tetrachloroethene detected in the private water supply system (0.3 ug/l) through the ingestion, inhalation, and dermal contact exposure pathways. Non-cancer health effects and a significant cancer risk are also not anticipated as a result of past exposure to tetrachloroethene at the maximum concentration (0.8 ug/l). These findings are consistent with the results of studies of humans and animals exposed to tetrachloroethene.[7] The studies indicate that the past and current concentrations detected in the private water supply system are below levels considered to increase cancer risk or to result in non-cancer health effects.

Tetrachloroethene was detected at the highest concentration (0.8J ug/l) in the private water system in November 1989. Tetrachloroethene concentrations have since decreased and over the last two years have ranged from 0.2 to 0.4 ug/l. It is anticipated that future results will continue to show this decreasing trend. No non-cancer health effects or significant cancer risk are anticipated in the future.

Child Health

The potential for exposure and subsequent adverse health effects are often increased for young children when compared with older children or adults. For example, children drink more water per body weight than do adults and therefore, receive higher exposures than adults. In addition to the potential for higher exposures of young children, the risk of adverse health effects is also increased. ATSDR and WDOH recognize that children are susceptible to developmental toxicity that can occur at levels much lower than those causing other types of toxicity.

WDOH evaluated the likelihood that young children exposed to tetrachloroethene in the private water supply well would experience adverse health effects. The above discussion summarizes the findings.

CONCLUSIONS

No apparent public health hazard exists for residents currently exposed or exposed in the past to tetrachloroethene at the concentrations detected in the private water supply system. Based on the trend of decreasing tetrachloroethene concentrations in the private water supply system, no apparent public health hazard is anticipated in the future.

RECOMMENDATIONS

1. Continue to monitor the private water supply system.

2. Provide the private water supply well system owner and users with a copy of this consultation.

WDOH is available to evaluate any new information and data about the water supply system.

Table 1: Past and Current Maximum Detected Concentration of Tetrachloroethene and Drinking Water Screening Levels

Contaminant	Past Maximum Groundwater Concentration [1]	Current Maximum Groundwater Concentration [2]	Drinking Water Screening Level	Source
Tetrachloroethene	0.8J ug/l	0.3 ug/l	0.7 ug/l	CREG [a]
			100ug/l	RMEG -Child [b]

J - Reported value is an estimate

1. Past maximum groundwater concentration obtained from the November 1989 to November 1998 sampling results.

2. Current maximum groundwater concentration obtained from the February 1999 sampling results.

a. Cancer Risk Evaluation Guideline (CREGs) are estimated media specific contaminant concentrations that are anticipated to result in one excess cancer risk in one million persons exposed over a lifetime. CREGs are derived from EPA's cancer slope factors (CSFs), also known as cancer potency factors. CSFs are cancer potency estimates derived for chemicals shown to be carcinogenic in animals or humans.

b. Reference Dose Media Evaluation Guidelines (RMEGs) are media specific health comparison values derived from EPA's reference dose (RfD). RfDs are estimates of daily exposure of a human to a chemical that is likely to be without an appreciable non-cancer risk over a specified duration of exposure.

REFERENCES

1. Mason County Sanitary Landfill, Final Closure Plan, Parametrix, April 1991.

2. Telephone conversation between B. Trejo, WDOH, and S. Kutz, Mason County Department of Health Services, June 3, 1999.

3. 1997 Groundwater Monitoring Annual Report, Mason County Landfill, Parametrix, February 1998.

4. 1998 Groundwater Monitoring Annual Report, Mason County Landfill, Parametrix, February 1999.

5. Telephone conversation between B. Trejo, WDOH, and S. Kutz, Mason County Department of Health Services, June 4, 1999.

6. Telephone conversation between B. Trejo, WDOH, and S. Kutz, Mason Co. Department of Health Services, June 7, 1999.

7. Mason County Landfill Quarterly Groundwater Data, Parametrix, June 15, 1999.

8. Toxicological Profile for Tetrachloroethylene (Update), ATSDR, September 1997.

9. American Cancer Society Facts and Figures, 1998.

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APPENDIX A
EXPOSURE ASSUMPTIONS

To obtain conservative daily exposure doses to evaluate non-cancer health effects and cancer risk associated with the ingestion, inhalation and dermal contact of tetrachloroethene, a child exposure scenario and a child through adult exposure scenario were used, respectively. An ingestion exposure dose was calculated using the following formula:

Ingestion Exposure Dose = C x IR x EF x ED)/ BW x AT.

C = Concentration of tetrachloroethene in water (mg/l)

IR = Ingestion Rate (liters per day)
Child (0 - 5 years): 1 liter per day
Young adult (6-15 years): 2 liters per day
Adult (>= 16 years): 2 liters per day

EF = Exposure Frequency (day/year)
It was assumed that people were exposed 350 days per year.

ED = Exposure Duration (years)
It was assumed that residents were exposed to contamination for 30 years. Thirty years represents the average time that a person spends at one residence.

BW = Body Weight (kg)
Child (0 - 5 years): 16 kg
Young adult (6-15 years): 40 kg
Adult (>= 16 years): 70 kg

AT = Averaging Time (days)
For exposure to carcinogens the averaging time is assumed to be 70 years x 365 days/year. For non-carcinogens, the averaging time is the actual length of the exposure period.

The calculated ingestion exposure dose was doubled to account for inhalation and dermal exposures.

APPENDIX B

NON-CANCER ADVERSE HEALTH EFFECTS
AND CANCER RISK EVALUATION

Evaluating Non-Cancer Adverse Health Effects

In order to evaluate the potential for non-cancer adverse health effects from exposure to contaminated media (i.e., soil, water, and air), a dose is estimated for each contaminant of concern. The doses are calculated for situations in which people might come into contact with the contaminated media. The estimated dose for each contaminant of concern under each situation is then compared to ATSDR's minimal risk level (MRL) or EPA's oral reference dose (RfD) to determine if there is a potential for non-cancer adverse health effects. MRLs and RfDs are derived from toxic effects levels obtained from human and animal laboratory studies. The toxic effects levels are expressed as either the lowest adverse effect level (LOAEL) or the no-observed adverse effect level (NOAEL). In human or animal studies, the LOAEL is the lowest dose at which an adverse effect is seen; the NOAEL is the highest dose that did not result in any adverse human health effect.

To account for uncertainty, the toxic effect levels are divided by safety factors (10, 100, or 1,000) to provide the more protective MRL or RfD. If a dose exceeds the MRL or RfD, the *potential* exists for adverse health effects. Therefore, a dose only slightly exceeding the MRL or the RfD would fall well below the toxic effect level. The higher the estimated dose is above the MRL or RfD, the closer it will be to the toxic effect level.

Evaluating Cancer Risk

By calculating a dose similar to that described above and multiplying the dose by the EPA cancer slope factor, the increased cancer risk can be estimated. An exposure to a contaminant which results in an estimated increased cancer risk of one additional cancer in a population of one million people exposed, averaged over a 70 year lifetime, is considered an acceptable risk, and is used as the screening value. In a population of one million men in the U.S., 333,000 (one in three) are expected to develop cancer from all causes in the lifetime (through 79 years of age). For U.S. women, the figure is 200,000.[9] The additional estimated cancer risk means that if those one million men are exposed for 30 years to this level of chemical, 333,001 would be expected to develop cancer. For the one million women exposed, 200,001 would be expected to develop cancer.

Glossary

Agency for Toxic Substances and Disease Registry (ATSDR)	ATSDRThe principal federal pubic health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Carcinogen	Any substance that can cause or contribute to the production of cancer.
Oral Reference Dose (RfD)	An amount of chemical ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA.
Comparison value	A concentration of a chemical in soil, air or water that, if exceeded, requires further evaluation as a contaminant of potential health concern. The terms comparison value and screening level are often used synonymously.
Contaminant	Any chemical that exists in the environment or living organisms that is not normally found there.
Cancer Risk Evaluation Guide (CREG)	The concentration of a chemical in air, soil or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a *comparison value* used to select contaminants of potential health concern and is based on the *cancer slope factor* (CSF).
Dose	A dose is the amount of a substance that gets into the body through ingestion, skin absorption or inhalation. It is calculated per kilogram of body weight per day.
U.S. Environmental Protection Agency (EPA)	Established in 1970 to bring together parts of various government agencies involved with the control of pollution.
Exposure	Contact with a chemical by swallowing, by breathing, or by direct contact (such as through the skin or eyes). Exposure may be short term (acute) or long term (chronic).
Groundwater	Water found underground that fills pores between materials such as sand, soil, or gravel. In aquifers, groundwater often occurs in quantities where it can be used for drinking water, irrigation, and other purposes.
Hazardous substance	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
Ingestion rate	The amount of an environmental medium which could be ingested typically on a daily basis. Units for IR are usually liter/day for water, and mg/day for soil.
Lowest Observed Adverse Effect Level (LOAEL)	LOAEL's have been classified into "less serious" or "serious" effects. In dose-response experiments, the lowest exposure level at which there are statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control.
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
Monitoring wells	Special wells drilled at locations on or off a hazardous waste site so water can be sampled at selected depths and studied to determine the movement of groundwater and the amount, distribution, and type of contaminant.
Minimal Risk Level (MRL)	An amount of chemical that gets into the body (i.e. dose) below which health effects are not expected. MRLs are derived by ATSDR for acute, intermediate, and chronic duration exposures by the inhalation and oral routes.
No apparent public health hazard	Sites where human exposure to contaminated media is occurring or has occurred in the past, but the exposure is below a level of health hazard.

No Observed Adverse Effect Level (NOAEL)	The dose of a chemical at which there were no statistically or biologically significant increases in frequency or severity of adverse effects seen between the exposed population and its appropriate control. Effects may be observed at this dose but were judged not to be "adverse."
Risk	The probability that something will cause injury, linked with the potential severity of that injury. Risk is usually indicated by how many extra cancers may appear in a group of people who are exposed to a particular substance at a given concentration, in a particular pathway, and for a specified period of time. For example, a 1%, or 1 in 100 risk indicates that for 100 people who may be exposed, 1 person may experience cancer as a result of the exposure.
Reference Dose Media Evaluation Guide (RMEG)	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a *comparison value* used to select contaminants of potential health concern and is based on EPA's oral reference dose (RfD).
Route of exposure	The way in which a person my contact a chemical substance that includes ingestion, skin contact and breathing.